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## A collaborative change experiment: Post-experiment evaluation of home telecare for elderly home dwellers

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### Abstract

This paper presents results from the final phases of a three-year collaborative change experiment that introduces telecare as a means for delivery of home care services to elderly home dwellers. During the five phases of the experiment, we have included a total of 78 participants in a new housing for local care homes in Oslo. Our goal has been to gather enough empirical knowledge to inform future design of telecare. We present and thematically analyze the results from a final post-experimental workshop and case study, and we use this analysis to discuss the overall findings of our research. Our main findings cover different aspects of the design of telecare, including organizational, technical and health aspect.

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**Keywords:** Elderly; Home care; Telecare; Usability; Two-sided interaction

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### 1. Introduction

This paper presents the results from a post-experimental workshop after a three-year long collaborative change experiment. The experiment studies the introduction of telecare-provided home care services by use of video consultation through the television. The experiment focuses on systematic examination of usability issues of telecare in controlled environment within a demo-apartment [1], as well as an evaluation of diagnostic issues that occurred when moving the technical solution into the private homes of the elderly participants [2]. Thus, the paper provides fruitful contribution to the field of human factors from the participants own perspectives focusing on the

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organizational and technical aspects of technology-supported home care services. The empirical setting for our field studies was a new housing of 87 care homes for elderly with an average age of 84 years, and their public home care service nurses. Throughout our research, we have focused on assessing human factors on both sides of the interaction of the care service including both elderly participants and home care service staff.

We begin by presenting an overview of related work concerning elderly people using telecare technologies in their homes, before we briefly describes the longitudinal collaborative change experiment. Then follows methods used in the study, as well as the results and findings. We end the paper by discussing the findings based on our results and relate these to related work.

## 2. Related work

Aceros, Pols and Domènech [3] have carried out an ethnographic study of elderly home dwellers using a personal alarm system to help them alert in cases of emergency. The aim of the technical assistance was to support the elderly home-dwellers' safety and well-being. However, the elderly felt home-bounded as the alarm did not work outdoors and the use of such technology contradicted with the purpose of elderly being independent; especially concerning elderly people's desire to more social activities outside their homes. [3] further argue that assistive technology stand the chance of failing in certain real-life cases due to its limitations. The use of such home-bound alarm systems can influence elderly people to feel unsafe outdoors, which in turn can result in safety alarms having a negative impact on their well-being. By locking elderly people into their homes due to fear, thereby making them more isolated and inactive, we end up in a situation opposite of the noble intentions behind supporting active and independent aging.

Greenhalgh *et al.* [4] have performed a study on assistive living and the actual user-needs of the elderly people. They address how increasing health challenges of the elderly people are likely to affect their ability to use assistive technologies, and the materiality of the introduced technologies; both the material features of the technology and the sociological implication of its use. [4] refer to findings similar as the EFORTT research team [5] who concluded that telecare is not a quick solution to support the growing elderly population. Neither does it replace traditional home care services as the technology itself cannot perform the care work. First and foremost, the technology has to actually function, and then be incorporated into the work practice of someone who can take action and follow up during alerts.

Compagna and Kohlbacher [6] explore design of assistive technologies such as the care robots for elderly people through the use of participatory technology development (pTD). The authors report several weaknesses of such an approach, yet conclude that it has the potential to work if designers and developers move their work into real user environment and include the various end-users, e.g. the care workers and the elderly people.

Clemensen and Larsen [7] studied introduction of telemedicine for treatment of foot ulcer in the home. They concluded that telemedical treatment can provide the home-dwellers with improved continuity in treatment as such consultation requires real-time collaboration with the home care nurse, patient and the doctor. However, they also experienced that introduction of telemedicine in the home resulted in coordination challenges such as the doctor having to wait for the home care nurse to arrive at the patient's home. Thus, the authors suggest that a function for coordination is included in the design of the technical solution.

Loe [8] explores the role of technology in relation to good and active aging from the perspective of the oldest old, including elderly adapters of technology, reluctant users and non-users. The author emphasizes the importance of capturing the elderly people's view on technology – and she further argues that the policy makers, designers and care givers should listen carefully to the elderly people who already have adopted technology into their lives.

## 3. Collaborative change experiment

The focus of this paper is the fifth and final phase of the three-year longitudinal collaborative change experiment illustrated in Figure 1. This final phase concludes the experiment and involves a post-experimental workshop and case study.



Fig. 1. Overview of the five phases included in our collaborative change experiment.

We have applied various methods during the five phases of the collaborative change experiment. Table 1 presents an overview of the applied methods, as well as the number of participants and the collected data. The methodic approach, as well as results and findings from methods [A]–[D] have been previously presented in [1,2]. Methods [E]–[F] were carried out during this fifth phase, and results from these two methods are presented in this paper.

Table 1. Overview of methods involved in the Collaborative change experiment.

#	Method	N	Collected data	Inquiry method
A	Preliminary field studies	15	Photographs, field notes, interview data	Home visit, unstructured interviews
B	Task elicitation workshop	11	Field notes, problem grading	Open discussion
C	Usability testing	8	Photographs, usability grading, video	Two-sided observation, usability assessment, statistical analysis
D	Diagnostic evaluation	34	Diagnostic grading, photographs, field notes	Post-interview, usability assessment, two-sided observation, questionnaire
E	Post-experimental workshop	6	Field notes, photographs	Categorical labeling, open-ended questions
F	Case study	4	Photographs, field notes, usability grading	Post-interview, questionnaire and observation

#### 4. Method

Throughout our research, the empirical context has mainly been a new housing of 87 care homes for elderly people. The average age at the housing is 84 years. A total of 78 participants have contributed to our studies throughout the five phases, and our approach have included a simultaneous observation and usability assessment of both elderly home dwellers and the home care service staff in order to capture both sides of the care service interaction. This final phase involved two activities – a case study and a post-experimental workshop – that did not require us to remain in our regular facilities. Instead, we held the post-experimental workshop in the headquarters of the home care workers, and the case studies were focused around the private homes of the four elderly participants and the corresponding home care worker's desk at the home care office.

##### 4.1. Case study

Due to the medical background of one of the authors, we had the opportunity to study our co-designed telecare system in a more participatory manner than just through direct observation. In collaboration with the home care service, the author was assigned the medical responsibility for four elderly home dwellers that all had previously participated in the usability testing and diagnostic evaluation. The case study replicated the work routines of the home care service – elderly participants were called from the home care service office, and those who did not answer were visited at home. The case study involved four elderly home dwellers that were visited daily for one week, and all interaction or attempts at interaction were logged.

#### 4.2. Post-experimental workshop

In order to capture some reflections from our long-contributing participants, we wanted to include a workshop in the final phase of the collaborative change experiment. Our research involves many domain experts and home care workers who do not have daily or direct contact with elderly home dwellers themselves, and therefore were unable to participate in our usability testing and diagnostic evaluation (method [C]-[D] in Table 1) as they both revolved around the interaction during delivery of home care services. In the post-experimental workshop, we were able to gather the team leaders in the district that have the daily responsibility for the home care workers that interact with elderly people. We built the workshop around a set of questions covering their responsibility, aims and future challenges in order to capture their experience with our change experiment and their perspectives on delivery of home care through telecare. The workshop involved six participants and we asked our participant to label some of the experienced issues into categories that would help us structure and analyze their perspectives.

### 5. Results and findings

In order to organize our results, we analyzed the data thematically and then categorized our identified issues into four problem areas. We divided the analysis into two parts; one analysis for the elderly people and one analysis for the home care workers. We selected an inductive approach to build our thematic analysis following the guidelines presented by Braun & Clarke [9]. In order to analyze the data gather on the work of the home care workers, we used the post-experimental workshop as our main source. From this workshop we had notes, interview transcription and labeling we used to elicit the main clusters of the analysis. We used the case study as the main source for the analysis of the interaction from the elderly home dwellers' side. The case study yielded field notes, answered questionnaires, photographs and observations that all contributed to the analysis. We supported both analyses with secondary data from the previously applied methods presented in Table 1. This section presents the results from our thematic analysis. Figure 2 presents the thematic analysis for the home care workers, while Figure 3 presents the similar analysis for the elderly care receivers. Table 2 and Table 3 gives an overview of the four identified thematic areas and the main findings for each area, the particular secondary sources, as well as key observations and quotes.

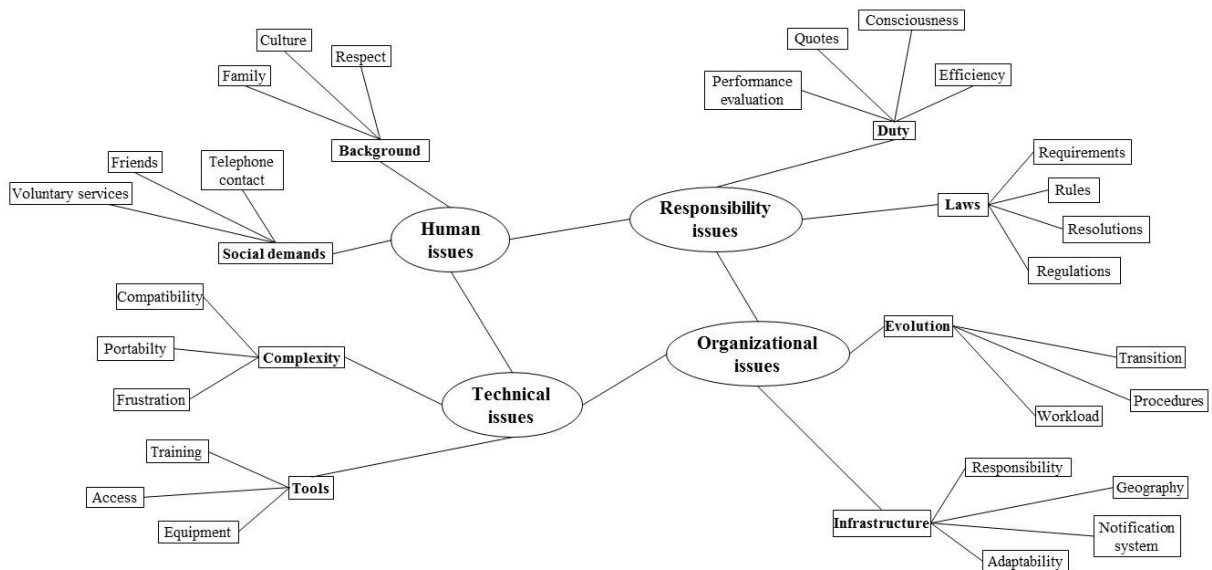


Fig.2. Thematic analysis - home care workers.

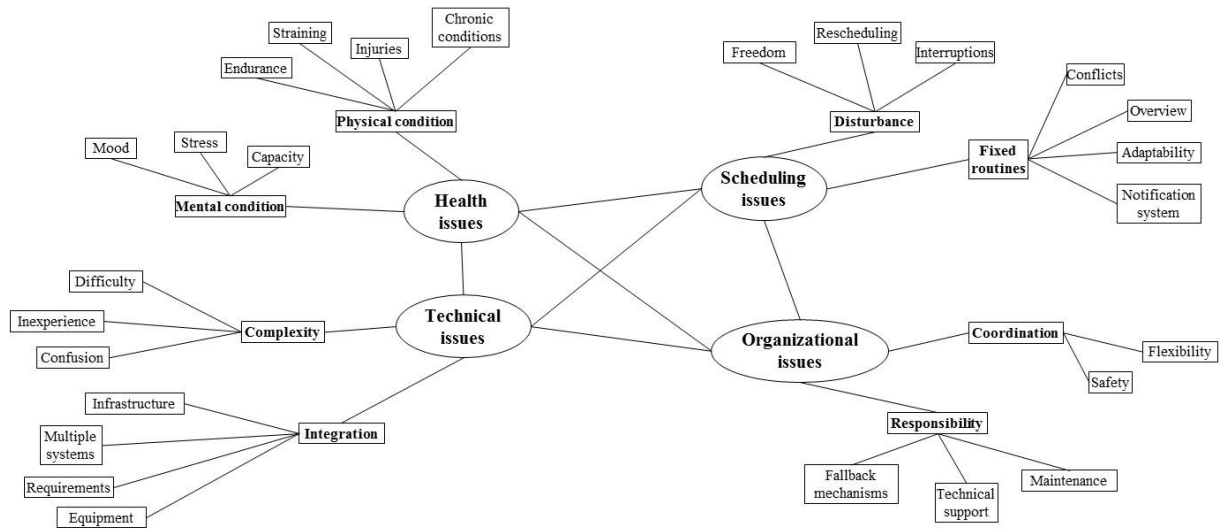


Fig.3. Thematic analysis - elderly care receivers

Table 2. Overview of identified issues and main findings - home care workers.

Issue type	Main findings	Secondary sources	Key observations or quotes
Health issues	Successful use depends on both physical and mental condition	[B], [C]	Mood and stress levels also affects their desire and capabilities to use the system properly
	Minor and fluctuating day-to-day issues strongly affects use	[A], [C], [D]	"I need to have a good day in order to operate the system"
Scheduling issues	May end up disturbing existing daily routines	[C], [D], [E]	If not individually coordinated, the calling time often conflicts with other scheduled appointments
Technical issues	Provides both flexibility and safety	[A], [C]	"How do I know if I have a missed call?"
	Further complicates the technical ecosystem in their homes	[D]	The interrelation between the television and the newly added camera was confusing to most participants
Organizational issues	The system requires high-speed Internet	[C], [D]	All technical incidents occurred due to Internet connectivity issues
	Requires maintenance from user	[C]	"I cannot find my remote control"
	Puts more pressure on timely delivery	[C], [D], [E]	Participants were waiting for the home care nurses to call also when they did not call on time

Table 3. Overview of identified issues and main findings - elderly care receivers.

Issue type	Main findings	Secondary sources	Key observations or quotes
Human issues	Different users have different expectations from the care service	[B], [C], [F]	Cultural, social and religious belonging affects the way care receivers look at the home care service
	It is difficult to have fixed nurses per care receiver	[B], [C]	Follow-up visits to non-responders disrupts the work flow
Responsibility issues	Laws and regulation prevents helping beyond the agreement	[A], [B]	The rules for care services are stricter regulated for municipal care givers compared to private care givers
	The care receivers often expect socializing company from the care givers	[B]	"We are not a social service"

<i>Issue type</i>	<i>Main findings</i>	<i>Secondary sources</i>	<i>Key observations or quotes</i>
Technical issues	Proper delivery is dependent on technical stability on both sides of the interaction	[C], [D], [F]	<i>“It is difficult to maintain good quality if our service is vulnerable to errors on the other side”</i>
	The system needs to be integrated with the existing smartphone infrastructure	[A]	The regulative barriers in the municipal hierarchy prevents or delays necessary integration
Organizational issues	Allows better continuity in follow-up as contact is easier to establish	[D]	<i>“If we can call care receivers at any time, even between others, then it is easier to follow up”</i>
	Requires reallocation of employees	[B]	Incorporation of large scale technology-supported care requires restructuration in the home care service

## 6. Discussion

### 6.1. Organizational challenges vs. technical issues

The use of assistive technologies was found achievable for active elderly people when we merely observed the interaction as an isolated event. However, the main challenge was to understand how we can incorporate assistive technology into the daily activities of the elderly participants, as well as coordinate this with their specific daily general condition. Our finding coincides with the work of Greenhalgh [4], especially concerning the sociological implications that the introduction of telecare technologies has on both end-user groups, namely elderly home dwellers and their care givers. Furthermore, we experienced that if the participants were not capable of responding to the telecare call, the necessary follow-up activities that were required to still provide them with the vital care services, were disrupting the work flow of the home care service staff. The elderly participants mostly expressed concerns about the technology usage. Even if organizational challenges were evident to them, they did not verbally express these challenges themselves. The participants did not mind that they were bedridden as they still received the service, although by human presence in their home rather than through the television. This aspect can be interpreted as a result of the elderly people experiencing the individual service delivery as a private matter; for the nurses on the other hand, a service delivery to an individual elderly home dweller is only one of several deliveries during a work shift. The team leaders at the home care service office reported that they consider the organizational aspect required to successfully incorporate assistive technology to be approximately 70 - 80 %, while technology only amounted to 20-30%. Moreover, they felt that incorporation of assistive technology required them to develop a set of new routines that needed adjustment over time as they learned from practice. The team leaders also stated that as new routines and technologies were incorporated into work practice, the organizational challenges were of lesser concern. At the same time, the technological issues represented a bigger concern in order to sustain the technical solution over time. The technical solution has to be robust in the sense that it does the delegated care task 24/7, and the solution has to ease the workload rather than demanding extra effort.

The team leaders also expressed concerns over the lack of infrastructure such as an overall user support system, e.g., a call center. These concerns were raised in two considerations: first, with regards to how we can handle users of assistive technologies that currently were not home care services users, but who could still benefit from assistive living, and secondly, with regards to dealing with ICT-support of technical issues. The team leaders viewed the role of the call center as “the heart” in a larger health care apparatus. Its main function would be to serve as a timely responder to the different alarms integrated into the existing or new housings for elderly people, or to coordinate access to services at the polyclinic for elderly care, or just for socialization among others.

### 6.2. Health issues and aging vs. assistive technology usage

We experienced that our elderly participants had increased health care challenges as the experiment unfolded. The elderly did not bring up their health issues during the experiment, however some of the participants were provided with both remote telecare and traditional care giving. Nevertheless, their declining health conditions affected the experiment as their mobility decreased, and many found it troublesome to answer the telecare call if they were located away from the television [2]. This interplay between health and technology yielded opposite

results of Acero *et al.*[3] who found that the technology restricted the mobility of the elderly by only functioning indoors. We experienced that the health of the elderly participants were restricting their mobility in using the stationary telecare solution. Greenhalgh *et al.*[4] also pinpoint that the health issues of elderly people have to be taking into consideration when designing assistive technology this user group.

The team leaders also agreed that some of the participants had fallen out of the target group of active aging elderly people during the experiment, but the participants themselves were eager to participate in the study. However, we learned from the experiment that telecare is not for all elders; as the elderly people experience increased need for complex health care services, the need for traditional local care within the home becomes increasingly vital.

### 6.3. *A need for improved prioritization of the “core” home care services*

Improved prioritizing of the home care services demands a more efficient use of scarce health care services. For instance, we have addressed the services that can be delegated to technology or be provided by others than the home care service staff. During the initial phases of the change experiment, we experienced that the active and independent participants expressed high motivation in testing and exploring technology usage. They were open to receive care in new ways in order for them to better blend the delivery of services into their daily lives. However, these elderly participants only received minor home care services, and none of these were physical care tasks, but rather practical tasks that the elderly could deal with themselves under supervision. Their experiences were similar to the results of Acero *et al.*[3] whose findings suggest that sometimes assistance in the home made care receivers home-bound, and restricted their mobility as they had to sit home and wait for the nurses to visit. Additionally, many of the participants expressed concerns about having different nurses, or even unknown nurses, on their doorstep several times during the day. However, elderly people with complex and severe health care challenges had an opposite view; they did not see the benefit of exploring new ways of delivery home care services as they did not have the energy. They all preferred traditional home care services and they all had complex home care service needs including physical care.

The team leaders similarly stated that technology such as telecare can never replace physical care, but rather be a supplement for minor care issues, e.g. reminding people to take medication, to eat, or just to supervise the general health condition. Greenhalgh *et al.*[4] also supports this statement. The team leaders further expressed a need for defining their core services as being physical care work, and they recommended delegating more practical routine tasks; for instance, reminders of medication could be delegated to technology and wound-care could be moved to the polyclinic for elderly care. They all emphasized the benefit of new housing adapted to increased self-reliance. They had experienced some elderly people with minor care needs not needing their services after moving into a new care home, while others who still needed their help were easier to assist as the new housing were better facilitated.

### 6.4. *Essential factors for the quality of care services*

The elderly participants and the team leaders considered timely delivery of services as the most essential factor for the experienced quality of service. We understand this perspective of timely delivery of services to mean as early as possible during the morning shift – and often as late as possible during the evening shift. On the other hand, the team leaders' perspective of timely delivery was related to delivering medication on time as prescribed by the GP, to assist bedridden elderly to get up before lunch time, or to timely measure the blood sugar of people with diabetes. The team leaders did also express that user satisfaction after delivery of service had an important impact on their own experience of quality of care. The elderly participants and the team leaders also agreed on the importance of providing regular nurses for a specific user. However, the team leaders saw immediate practical concerns with covering staff for each of the work shifts during a day – a fixed nurse for each and every user is difficult to fulfill. The team leaders also responded that factors such as tactile and oral communication were essential for the experience of quality of care in order to have a joint understanding of what is happening during the collaboration.



### 6.5. Requirements for successful implementation of assistive technology

The participants unanimously agreed that stable and sufficient network capacity was the most important prerequisite for a successful implementation of assistive technology. During the experiment, we suffered with unstable network capacity within the private homes of the elderly participants. The team leaders stated that they needed to allocate employee resources that dealt with assistive technology tasks in order to handle incorporation of technology supported care to larger groups of users. Compagna and Kohlbacher[6] and Loe[8] have emphasized the importance of including end-users' perspectives, as well as supporting actual user-needs when designing assistive technology for care services. We agree that having end-users involved from the initial planning when implement assistive technology within a real user environment can prove helpful. We also believe the technology should support actually user needs in order to be perceived as appropriate. Our experiences during this three-year change experiment have been mostly informative when moving from controlled environment [1] to real user environment [2], and overall constructive with regards to how end-users like elderly people and their care givers are influenced when introducing technology into the care work.

## 7. Conclusion

In this paper, we have reported findings from a post-experimental workshop and case study that concludes our three-year collaborative change experiment. During the experiment, we have replaced a selection of traditional home care services for elderly care receivers with telecare-provided services. Our main findings from this study are as follows: Firstly, the introduction of telecare is more organizationally demanding on the caregiver than having to learn how to interact and use the technical solution itself. However, the elderly people and the home care nurses experienced organizational and technical issues differently as the elderly participants merely saw the delivery of services as something individual, while the home care service staff had to incorporate telecare into the workflow and deliver it to several care receivers. Secondly, our elderly participants were vulnerable to increased health care issues, which again affected their ability to appropriate telecare-provided home care services. Telecare such as videoconference is most suitable for active elderly people with minor health issues as telecare can never replace physical care. Thirdly, telecare-provided services could contribute to increased timely delivery of services. Timeliness is valued as the most essential factor of the quality of services according to both the elderly people and the team leaders. Fourthly, the most essential requirement for telecare-provided home care services is a stable and sufficient network capacity on both sides. Finally, the team leaders expressed a fundamental need of extra work resources in order to organize large-scale implementations of assistive technology such as telecare-provided services.

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